SALMON RECOVERY SCIENCE REVIEW PANEL
Report for the meeting held
March 18-19, 2002
Southwest Fisheries Science Center, Santa Cruz Lab
National Marine Fisheries Service
Santa Cruz, CA

This introductory material (pp. i-iii) is available on the RSRP web site. As an aid to the reader, we are now including it with individual reports.

Recovery Science Review Panel

Robert T. Paine	**University of Washington, Chair**
Ted Case	**University of California – San Diego**
Frances James	**Florida State University**
Russell Lande	**University of California – San Diego**
Simon Levin	**Princeton University**
William Murdoch	**University of California – Santa Barbara**

The Recovery Science Review Panel (RSRP) was convened by the National Marine Fisheries Service (NMFS) to help guide the scientific and technical aspects of recovery planning for listed salmon and steelhead species throughout the West Coast. The panel consists of six highly qualified, independent scientists who perform the following functions:

1. Review core principles and elements of the recovery planning process being developed by NMFS.
2. Ensure that well accepted and consistent ecological and evolutionary principles form the basis for all recovery efforts.
3. Review the processes and products of all the Technical Recovery Teams (TRTs) for scientific credibility and ensure consistent application of core principles across Evolutionarily Significant Units (ESUs) and recovery domains.
4. Oversee peer review for all recovery plans and appropriate substantial intermediate products.

The panel meets 3-4 times annually, and submits a written review of the issues and documents discussed at each meeting.

Expertise of the Panel Members

Dr. Robert Paine (Chair), University of Washington

- **Field of expertise:** marine community ecology, complex ecological interactions, natural history;
- **Research:** About 100 scientific publications.
- **Awards and Scientific Leadership:** member, National Academy of Sciences; Robert H. MacArthur award, Ecological Society of America; Tansley award, British Ecological Society; Sewall Wright award, American Society of Naturalists; Eminent Ecologist ward, Ecological Society of America; past president of the Ecological Society of America; member of National Research Council committees; member of editorial boards

Dr. Ted Case, University of California-San Diego

- **Field of expertise:** evolutionary ecology, biogeography and conservation biology;
- **Research:** More than 130 scientific articles published, including papers in *Science*, *Nature*, *American Scientist*; featured in *Discover* magazine and on public television and radio.
- **Awards and Scientific Leadership:** Board member for National Center for Ecological Analysis and Synthesis; former Chair of the Department of Biology at UCSD; author of leading textbook on theoretical ecology

Dr. Frances C. James, Florida State University

- **Field of expertise:** conservation biology, population ecology, systematics, ornithology;
- **Research:** More than 105 scientific articles published.
- **Awards and Scientific Leadership:** Eminent Ecologist award, Ecological Society of America; past president of the American Institute of Biological Sciences and the American Ornithologists' Union; member of National Research Council committees; service on editorial boards; Board of Governors for The Nature Conservancy, member of the National Academy of Arts and Sciences

Dr. Russell Lande, University of California-San Diego

- **Field of expertise:** evolution and population genetics, management and preservation of endangered species, conservation and theoretical ecology;
- **Research:** More than 116 scientific publications.
- **Awards and Scientific Leadership:** Sewall Wright award, American Society of Naturalists; John Simon Guggenheim Memorial Foundation Fellow, MacArthur Foundation Fellow, Member American Academy of Arts and Sciences; Past President of the Society for the Study of Evolution; developed criteria for classifying endangered

species adopted by the International Union for Conservation of Nature and Natural Resources (IUCN)

Dr. Simon Levin, Princeton University

- **Field of expertise:** theoretical/mathematical ecologist;
- **Research:** More than 300 technical publications.
- **Awards and Scientific Leadership:** member, National Academy of Sciences; member, American Academy of Arts and Sciences; Robert H. MacArthur award recipient from the Ecological Society of America; Statistical Ecologist award from the International Association for Ecology; Distinguished Service Award from the Ecological Society of America; Okubo award, Society for Mathematical Biology; member of many National Research Council committees; member of the Science Board, Santa Fe Institute; former Board Chair, Beijer International Institute of Ecological Economics; Board of the Committee of Concerned Scientists; past President, Ecological Society of America; past President, Society of Mathematical Biology; and Guggenheim Fellowship

Dr. William Murdoch, University of California-Santa Barbara

- **Field of expertise:** theoretical and experimental ecology, population ecology;
- **Research:** More than 120 scientific publications.
- **Awards and Scientific Leadership:** Robert H. MacArthur award, Ecological Society of America; President's award, American Society of Naturalists; Guggenheim Fellow; member, American Academy of Arts and Sciences; Founder, National Center for Ecological Analysis and Synthesis; Director of California Coastal Commission 10-year study of a coastal nuclear power plant; Board of Governors, the Nature Conservancy

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Dr. Beth Sanderson

- National Marine Fisheries Service liaison to the Recovery Science Review Panel
- Recovery Science Review Panel report coordinator

Dr. Richard Farr

- Science Writer, Northwest Fisheries Science Center

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I. INTRODUCTION

A partial panel (Case, James, Lande, Murdoch and Paine) met at the Southwest Fisheries Science Center. In addition to our usual mission—offering independent advice to NMFS on recovery of endangered salmonids and offering advice to the Technical Recovery Teams (TRTs)—this meeting was intended to familiarize the panel with the challenges facing salmon recovery in California.

The information presented to the Panel in Santa Cruz was appropriate, especially given the limited timeframe. These are some of the facts that we learned:

- There are only minimal stock-specific data on coastal chinook, steelhead and coho;
- More than 90% of steelhead in the Central Valley are hatchery fish, and there have been no new data on them since 1993;
- There has been very little coded-wire tagging of hatchery fish in California;
- The enormous success of the hatchery-based Sacramento fall chinook run has disguised a precipitous decline in the spring run, from 600,000 to perhaps 300 fish in recent years (with subsequent increases to 9000-18,000 fish).

We mention these facts at the outset because they identify a fundamental quandary facing the California TRTs, and thus the challenge posed to the RSRP: *What kind of advice can be given when crucial data are missing or limited?*

The sections that follow summarize our impressions.

II. NATURE AND LIMITATIONS OF THE AVAILABLE DATA

We learned that, compared to TRTs in the Northwest, California has limited data in many areas, including population sizes and long-term trends in escapement (numbers of adult fish returning to fresh water) and estimates of the fitness of hatchery fish (from coded wire tags or adipose fin tagging). Even so, the available data for Central Valley stocks is significantly better than for coastal stocks and steelhead. The data on spring and winter Chinook may even be adequate for the types of analyses outlined in the VSP document produced for the Pacific Northwest (McElhany et al 2000).

We were told that three quarters of the chinook caught along the Pacific Coast outside Alaska are in the California commercial fishery. Most of these are hatchery fish; their straying rates are believed to be high, but are largely unknown because hatcheries are still doing very little marking (less than 10% according to Yoshiyama et al 2000).

The California environment differs in significant ways from that of the Pacific Northwest:

- California's coast includes at least two marine biogeographical provinces. River systems inhabitable by salmon and steelhead span climates varying from the relatively wet Pacific Northwest to arid landscapes around San Diego. The implication is that one standardized recovery protocol cannot be fit to all salmon ESUs.

- Terrestrial disturbance regimes in California generate an environment for salmonids during their freshwater phase that is substantially different from and more varied than they experience to the north. California rivers and streams are susceptible to prolonged droughts and catastrophic turbidity associated with extreme weather events. The latter reflects in part a negative and indirect impact of forestry practices. In particular, predicting stock robustness and managing stocks is rendered difficult by the interplay between frequency of fire in watersheds containing salmon habitat, high spatial variation in rainfall, and the resultant production of average stream water temperatures in excess of salmon thermal tolerances.

- A substantial fraction of watershed areas is privately held. The problem was identified and coarsely quantified, but not discussed.

- Some of the coastal streams may be occluded by sand bars, which form and disappear at intervals ranging from months to years. The process emphasizes the management necessity of having accurate stock [ESU] identification and a quantitative grasp of the frequency of straying and identity of the founder stock.

III. RESPONSE OF THE SANTA CRUZ SALMON GROUP TO DATA LIMITATIONS

One component of defining ESUs is adequate genetic information. The Panel heard a report on mitochondrial DNA and nuclear microsatellite diversity in hatchery and wild steelhead (*O. mykiss*) in S. California. Our impression is that such information is limited for all California salmonids. Further, we heard very little about the extensive database associated with the conservation hatchery at the Bodega marine lab. In the absence of data known to be directly relevant to delisting criteria, there is a danger that focusing on the available data will actually lead to incorrect delisting criteria. We saw in the salmon group's presentations at Santa Cruz some reason to be concerned about this possibility. The group has responded to the underlying paucity of data with some imaginative analyses of data that do exist. The question is whether these analyses are the best way to do TRT work in a data-poor environment; on the whole, we think not.

For example, we were presented with a metapopulation patch-occupancy model for coho; this may not be very useful from a management point of view in any case, but especially not when based on presence/absence data that offers too much opportunity for false negatives and at a small spatial scale where individual fish movements can produce

pseudo turnover. Another example is dealing with the absence of adequate time series data by trying to develop recovery criteria by studying disturbance regimes. This could be useful in a PVA model for identifying likely spatial patterns of catastrophes (due to floods) and in accounting for missing year classes (as with coho along the central California coast).

A third TRT member recommended doing watershed-level analyses at different spatial scales, and emphasized understanding sediment yield along the northern California coast—a top-down approach. This is OK for descriptive work, but unlikely to help TRTs with their assignment because there is presently no way to connect the timing and amount of sediment disruption with the recruitment success of individual subpopulations. If this relationship could be firmed up, then sedimentation, since it can be readily measured over wide areas, could prove useful.

Spatial analyses of flood events may also provide insight into the "coherence scale" of this particular type of physical disturbance. Two problems with this analysis may be mentioned. Again, it is not clear how reliably measures of flood disturbance translate into population/ demographic disturbance, especially over more than the short term. Second, there are many other potential sources of "disturbance," each with presumably its own spatial coherence scale. Some of these, such as declines in prey species in streams, may not be correlated easily with measured physical factors. Thus, the emphasis on physical measures that are available may focus attention on the wrong variables for determining possible metapopulation structure.

For extinction / colonization estimates, the typical area sampled at each site is probably too small to give insight into colonization and extinction rates of subpopulations that might collectively make up a metapopulation. It might be better to analyze the data in a geographically explicit context by lumping the data within basins or other natural units. The data may then define the spatial distribution of fish among natural units, and perhaps indicate trends in occupancy rate within at least some of these spatial units. Spatial and temporal autocorrelation analysis of the small-scale occupancy data might be informative as to the natural units of population structure. It would also be important to use the existing data to test whether the probability of resampling a site is independent of past occupancy. The best use of this data in recovery planning might be simply to indicate recent trends in populations among drainages or other larger spatial units.

The geographic extinction / colonization analyses could be used to create highly precautionary delisting criteria, with the explicit recommendation that these could be modified in the light of new data. The analyses could also be used to develop a sampling scheme to provide relevant data (e.g. distribution and size of populations in major watersheds along the coast).

In closing this section, the Panel would like to reiterate that the California TRTs find themselves in an inherently difficult situation. While we are critical of many approaches being tried, we do not pretend to have provided a superior strategy. Instead, the next section offers some questions that may provide a context in which one can be developed.

IV. CRITICAL QUESTIONS FOR THE CALIFORNIA TRTS

Focusing on the following questions may help the California TRTs to forge an effective strategy in these data-poor circumstances:

1. What proportion of spawning Central Valley chinook and steelhead are of hatchery origin? The Pacific Fishery Management Council and NMFS need this answer if they are to use reliable escapement and jeopardy targets when setting ocean harvest regulations.

   We note that the data will have to come from a marking program for hatchery fish. Until there is far more consistency in tagging hatchery fish, it will not be possible to make reliable estimates of populations of naturally-spawning salmon or the effects of harvest upon them. We also need tagging of wild fish to obtain better estimates of straying rates.

2. Can habitat improvements and/or water flow regulation in streams and rivers allow salmon populations to increase? We think the costly efforts supported by the Central Valley Project Improvement Act (CVPIA), the multi-agency CALFED program ($195 million in 2001) and the California state program, could design its projects to allow comparisons in an experimental framework, thereby allowing better inferences about the value of the projects. Spring Chinook escapement was up after controlling for diversions at Butte Creek, Deer Creek and Mill Creek in the Central Valley, so there is a need to sample unscreened diversions and estimate the magnitude of this problem generally. The recovery plans could make explicit recommendations along these lines.

3. The Central Valley fall chinook show a dramatic increase in escapement from about 1995 (slide 34 of Steve Lindley's talk). This coincides with stricter harvest limits but also with better ocean conditions, and presumably increased off-site hatchery releases (although the data shown by Lindley on this point stop at 1995). Is it possible to assign relative strengths to these factors in accounting for recent escapement trends and if so how?

More general issues, of concern to California TRTs because they are of concern to all salmon restoration efforts, include the following:

- Are ocean conditions the primary limiting factor for salmon, as opposed to harvest or in-river management? (Extensions of recent studies, e.g. Roemmich and McGowan 1995; Boydstun 2001; Hare et al. 1999, expect a big return this year because ocean conditions are favorable.)
- To what extent is there loss of genetic diversity in listed ESUs (see Levin and Schiewe 2001)?
- Is supplementation of breeding stock with conservation hatchery fish really beneficial? (Cf. for example Ford 2002, Waples et al 2002.)

- Given the high hatchery production for fall chinook, is it worthwhile to try to assess impacts to wild populations, both in terms of genetic introgression and competitive effects by hatchery fish?

V. CONCLUSION AND RECOMMENDATIONS

To complete their work in the next two years, the California TRTs will have to be very explicit about their level of uncertainty, and will have to include in their plans the development of a new research and monitoring program and a clear indication of what steps are being taken to assure continuing progress.

Part of the RSRP's role is to encourage methodological consistency across the TRTs, and we believe that the California TRTs should continue to attend the NW TRT meetings and study how the NW teams work. The NWFSC produced an excellent document on research needs (the "Salmon Research Plan," Vols 1 & II); their colleagues in California should look closely at it.

California TRTs need not be intimidated by the head start made by the larger group in the Pacific Northwest, which has also complained about data gaps. In fact, we think the California TRTs can set an example by developing priorities for an efficient new sampling program and working to get it implemented during the next two-year period, a project that will probably take collaboration with the California Department of Fish and Game and probably the Pacific Fishery Management Council.

For delisting criteria, California TRTs need to summarize the geographic distribution of each ESU along with whatever information is available on within and between population genetic variation and demography. We did not hear any details about the ongoing genetics work at the Santa Cruz laboratory or recent PVAs for winter Chinook (Botsford and Brittnacher (1998); Lindley et al. 2000, Lindley and Mohr (in press).)

California can begin with the listing criteria and then state what information is most needed. Likewise, TRTs should try to rank the most probable threats for each ESU based on current information, even though it is incomplete.

The current paucity of population data, and consequent high uncertainty in population status and trends in several stocks outlined in the presentations, implies that the initial recovery plans and delisting criteria should apply the precautionary principle (O'Riordan et al. 2001, IUCN 2001), which would call for exceptionally high protection until new evidence shows that it is not necessary. As part of the recovery plans serious effort should also be put into outlining a long-term program for collecting salmonid population data for California patterned on existing practices in Oregon and Washington. This might encourage concerned state agencies to begin collecting the relevant data in order to refine the recovery goals and delisting criteria, because with better data in the future these might not have to be as precautionary as initially dictated by the current high uncertainty.

The lack of extensive quantitative population data on most salmonid stocks in California suggests that initial precautionary recovery goals and delisting criteria might be based on general criteria outlined in the NMFS Viable Salmonid Populations document (NMFS 2000), combined with objective, population-based criteria (for listing and delisting) such as those currently used by IUCN (IUCN 2001). A previous RSRP report (RSRP 2001) outlined the need for such an approach in practice, even in Oregon and Washington, with specific population viability criteria determined insofar as possible by stochastic population models based on available data. This RSRP report also included detailed suggestions concerning population viability analysis, particularly on dealing with uncertainties in population data and dynamics.

The RSRP cannot too strongly emphasize that the California TRTs' task of formulating effective salmonid recovery plans depends on an increased level of cooperation among state and federal agencies, especially with respect to sharing data in a common repository. It will be impossible to measure wild fish recruitment rates and determine possible hatchery impacts on wild fish without better data being available.

We urge the California TRTs and the Santa Cruz Lab to make a list of the important questions, estimate what actions and time commitments will be required to answer them, and then set clear priorities in the light of that knowledge.

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